

Properties of Elastomer Blends Studied by X-ray Microscopy

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Introduction: Good adhesion between chemically distinct elastomers is critical to the performance of elastomer blends and laminates in a wide variety of industrial applications. It is well known that the mechanical properties of blends are directly related to their interfacial properties. For example, automobile tires are composites of rubber materials which are arranged in such a manner that the tire functions properly. The nature and physical properties of the interfacial structure are directly related to the chemical structure of the polymer or mixtures of polymers in each layer, e.g. butyl rubber, styrene-butadiene rubber, natural rubber, polyisoprene.

One of the new families of isobutylene-based elastomers is brominated poly(isobutylene-co-paramethylstyrene) (BIMS), a synthetic terpolymer of isobutylene, para-methylstyrene, and para-bromomethylstyrene. The predominantly isobutylene-based terpolymer backbone is fully saturated which imparts high ozone and UV stability and impermeability to gases, while the para-methylstyrene component is used to control the modulus that can be varied from elastomeric to high modulus, glassy ($T_g 100^\circ\text{C}$) materials.

STXM microscopy is used to examine the phase composition of blends of BIMS and deuterated polybutadiene (dPB), and how styrene-butadiene rubber (SBR) compatibilizes this blend system. AFM and STXM measurements are used to complement Neutron Reflectometry (NR) of these blend systems [ZL&00].

Methods and Materials: Blends of dPB/BIMS (50/50 wt%) and dPB/BIMS/hSBR (45/45/10 wt%) were spun cast onto Si_3N_4 membranes and annealed in a vacuum oven for 18 hours at 150°C . (NB see ref. ZL&00 for additional details). The polymers dPB and BIMS separate into different phases upon annealing. Transmission X-ray microscopy images were recorded on the SUNY-SB STXM on the X1A undulator.

Results: **Figure 1** presents the STXM image of an annealed dPB/BIMS (50/50 wt%), recorded at 285 eV. This energy corresponds to the $\text{C } 1s(\text{C-H}) \rightarrow \pi^*_{\text{C}=\text{C}}$ transition in unsaturated polymers. Since the concentration of $\text{C}=\text{C}$ double bonds is much higher in dPB than in BIMS, dPB domains will appear dark in the transmission images. In figure 1, extended BIMS domains can be identified within the dPB matrix. **Figure 2** presents the STXM image of an annealed dPB/BIMS/hSBR (45/45/10 wt%) blend, also recorded at 285 eV. Here, the BIMS domains are round. By comparing figure 1 to figure 2, we see that the addition of SBR copolymer reduces the size of the BIMS domains. These results indicate that SBR compatibilizes the BIMS/dPB blend.

References: ZL&00 Y. Zhang, W. Li, B. Tang, M.H. Rafailovich, J.C. Sokolov, D. Gersappe, D.G. Peiffer, Z. Li, A.J. Dias, K.O. McElrath, S.K. Satija, M.Y. Lin, S.G. Urquhart, and H. Ade, *Macromolecules* (Submitted).

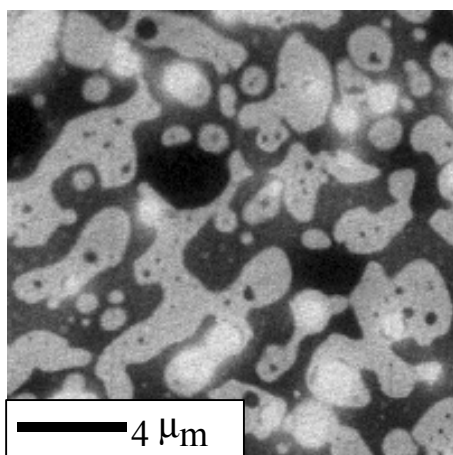


Figure 1. STXM image of a dPB/BIMS-1 (50/50 wt%) blend supported on a Si_3N_4 membrane, recorded at 285 eV. The dark areas correspond to the dPB phase.

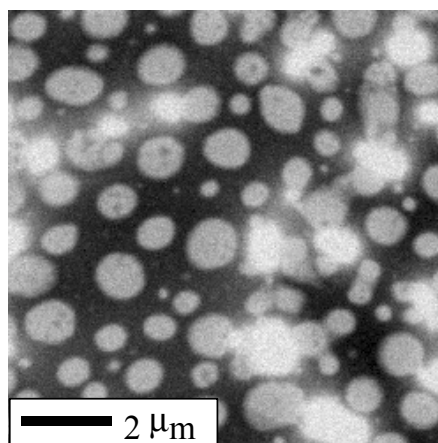


Figure 2. STXM image of a dPB/BIMS/hSBR (45/45/10 wt%) blend, recorded at 285 eV. The dark areas correspond to the dPB phase.